Resonant Modes in GaN photonic crystal defect cavities

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Photonic Crystal are of high interest for optoelectronic devices for numerous applications, e.g., as small volume resonators, on-chip waveguides, or for light extraction. These applications have successfully been demonstrated in other III/V material systems, such as InP or GaAs. However, there are only few reports on photonic crystals in the Nitrides. The reasons for this are, that the short emission wavelength of these materials in the visible range make the fabrication of significantly smaller features necessary to observe photonic effects, that GaN itself is more difficult to pattern, as it is chemically inert and does not feature a conventional wet etch.

We have developed a process based on electron-beam-lithography and reactive ion etching to produce photonic crystals with a lattice constant of a=200nm, by the use of a SiO_2 hard mask. We will also demonstrate, how these structures can be successfully underetched by means of photoelectrochemical etching (PEC), to form fully free-standing GaN membranes with active layers such as InGaN multi quantum-wells in the slab. Such membranes allow the confinement of the light in the vertical direction by the surrounding lower index material (air), and can be used in photonic crystal waveguides or cavities.

We will show results obtained on a H2 photonic crystal defect cavity in a triangular lattice. Low-Q modes are observed around wavelengths as short as λ=480nm, and the performance of the fabricated devices will be compared to FDTD simulations.